



Carnegie Mellon
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NRO's Use of CMMI in System Acquisition

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Objective

- Organizational Context
- Focus on Process Maturity for IMINT
- Focus on Process Maturity for FIA
- Description of Software Capability Evaluations (SCE) for FIA
 - Source Selection SCEs
 - Contract Execution SCEs
- Lessons Learned
 - Use of SCE Methodology
 - CMMI



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National Reconnaissance Office (NRO)



*Freedom's Sentinel in Space: One Team,
Revolutionizing Global Reconnaissance*

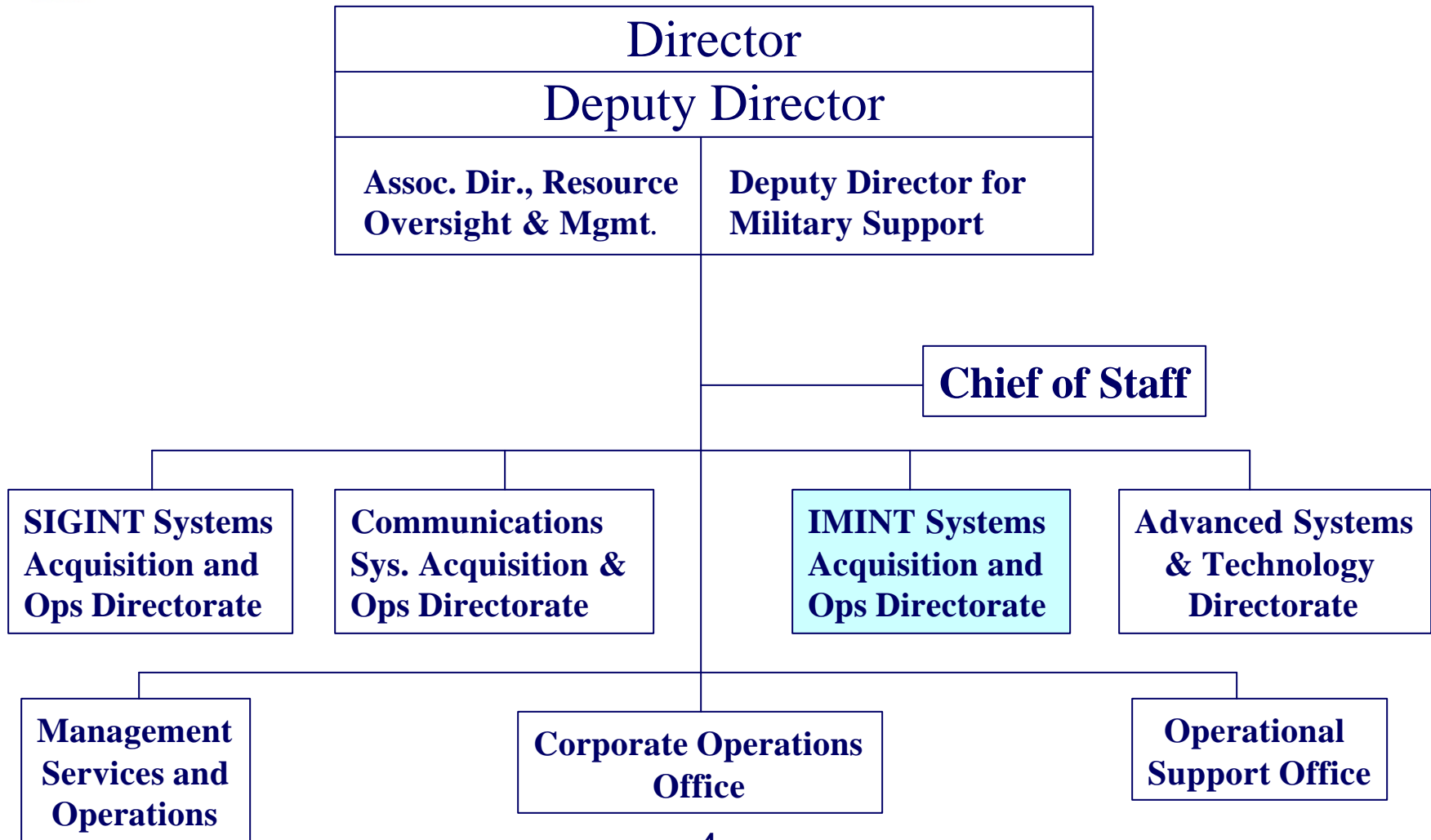
Mission of the NRO: Enable U.S. global information superiority, during peace through war. The NRO is responsible for the unique and innovative technology, large-scale systems engineering, development and acquisition, and operation of space reconnaissance systems and related intelligence activities needed to support global information superiority.



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NRO at a Glance





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Rationale for Process Focus in IMINT₁



- **1996:** SA-CMM Assessment of Imagery Development Programs
 - Finding: *“IDP lacked a consistent, rigorous, documented risk management practice”*
- **January 1997:** Software Risk Evaluation (SRE) performed on a major IMINT contractor
- **April 1997:** SRE performed on the Government program office



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Rationale for Process Focus in IMINT₂



- **May 1997:** Team Risk Management between Government and major command and control contractors began
- **June 1997:** All IMINT development programs began risk management training
- **1997 - present:** All IMINT acquisitions are managed using proactive risk management methods
- **1997:** Work began on reducing the risk of selecting immature suppliers for the Future Imagery Architecture (FIA) program

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Future Imagery Architecture (FIA)

- FIA is the NRO's initiative to define, acquire and operate the next generation imagery satellite architecture
- Working with NRO's mission partner and consumers of intelligence imagery products to implement user requirements
 - Integrate into the US Imagery and Geospatial Information System (USIGS).
- FIA will provide a cost-effective, best value imagery architecture comprised of more capable imagery satellites which are expected to be launched in this decade.



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Rationale for Process Focus in FIA



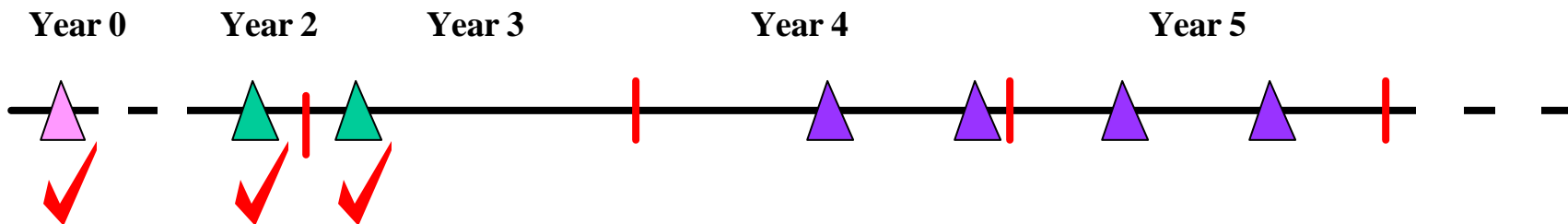
- FIA development is a huge system and software engineering feat
- System Engineering and Software Development pose big risks in FIA program
 - Several Million SLOC in FIA program
 - Dispersed engineering & development locations
 - Multi-contractor teams using different processes
 - Combination of legacy re-use, COTS integration and new software development efforts
 - Real cost and schedule constraints



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Summary Plan for FIA SCEs



Year 0: Conduct series of source selection SCEs for all FIA Offerors
Year 2/3 : Conduct baselining SCEs for primes and subcontractors
Year 4: Conduct “delta” SCEs for primes and subcontractors
Year 5 Conduct “statusing” SCEs for primes and subcontractors

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Source Selection SCEs



Baselining SCEs

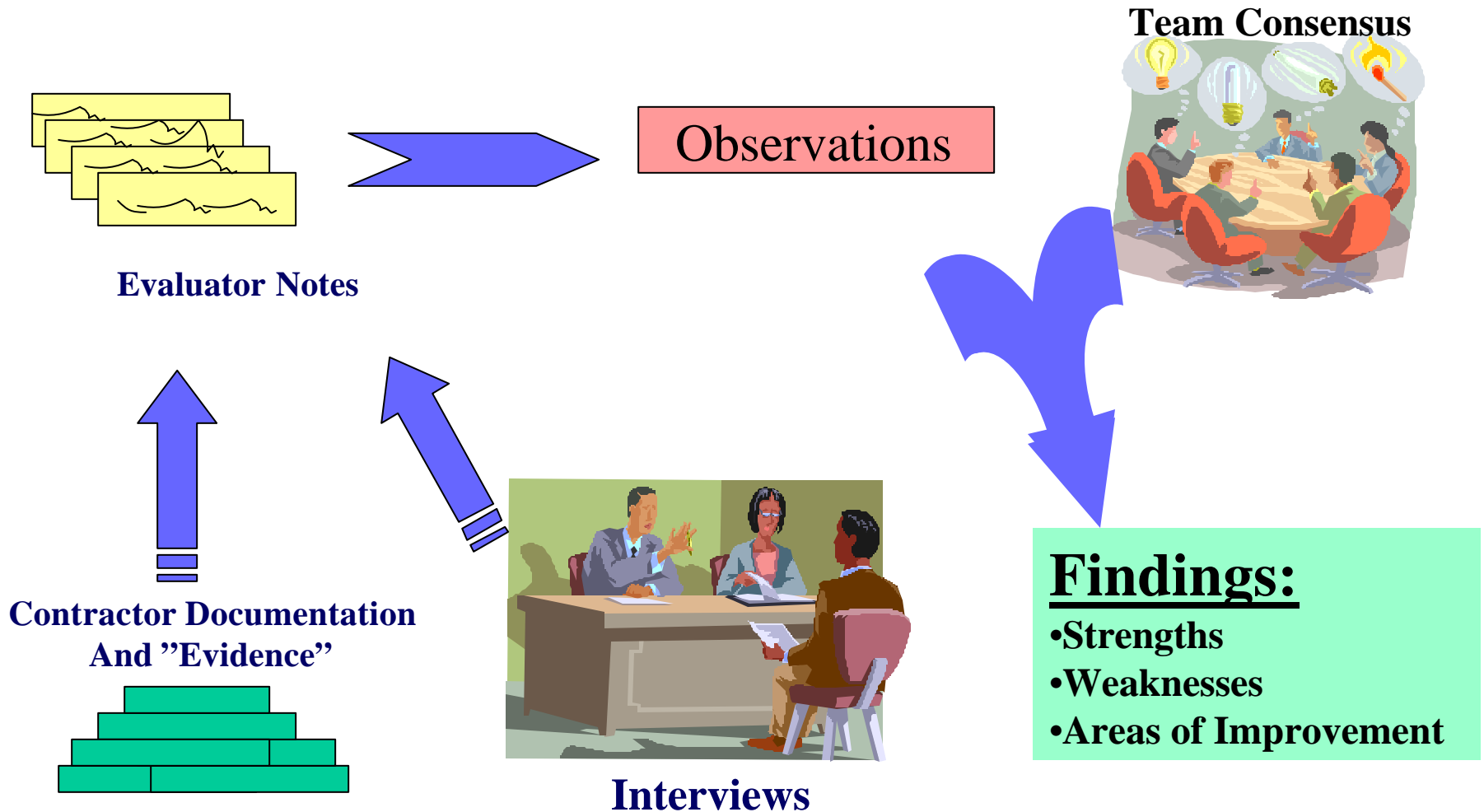


Delta SCE / Statusing SCE



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SCE Methodology (V3.0) for FIA Source Selection





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Source Selection SCEs

- Evaluate “representative” programs proposed by offeror
 - **Pre-proposal submission**
- Identify strengths and weaknesses of potential contractor teams
 - **Contractor proposal submissions indicated their assessed level through CBA-IPI**
 - **SCE provided objective evidence of capabilities– but no level ratings**
- SCE conducted in one central location for each contractor team (source selection expediency and fairness) prior to proposal submission
- Software focus only (SW CMM)
- SCE results (strengths and weaknesses by KPA) available during source selection “discussions” process

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Use of SCE Results During Source Selection



- Source Selection:
 - SCE findings factored into software process evaluation criteria along with proposal and past performance data
 - Proved to be key discriminator in source selection decision
 - More valuable than past performance data



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Use of SCE Results During Contract Execution



- Provides additional insight for management
 - “Leading indicators” for potential problem areas
 - Used by both government and contractor management
- Incentivizes contractor process improvement activities
 - Strength, weaknesses, improvement activities turned over to corporate / project process groups
 - Action plans formulated based on joint contractor / government priorities



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Contract Execution SCEs

- Evaluate actual FIA processes and capabilities
- Motivate FIA contractors to improve their capabilities (gov't product)
- Conduct SCE at relevant development/engineering locations to better gauge on-site capabilities
 - **Prime and subcontractors**
- Look at both software and system engineering capabilities (CMMI-Staged)
 - Primary focus on level 2 and 3 PA's – but no "ratings"
- Gov't SCE team travels to contractor sites to reduce contractor cost and schedule impacts
- SCEs conducted every 12 – 18 months to identify deltas
- Outbriefs conducted at each development site



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Enabling Factors for Contract Execution SCEs₁

- Program Office SCE Team trained / experienced with SW-CMM, CMMI, and SCE Method
 - Corporate “observers” at each site
- Documentation review conducted prior to site visits via contractor’s robust electronic development environment
 - 2.5 days of on-line documentation review
 - 242 draft observations
- Constructive alliance between project process team and government SCE team



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Enabling Factors for Contract Execution SCEs ₂



- Tailoring of “organizational scope” for SCEs based on contractual relationship of primes/subs
 - “Organization” composed of multi-corporation teams supporting project segments
 - Phase I: Common processes across primes/subs
 - Phase II: Compatible (but different) processes across primes/subs

“Organization” = Project or Project Segments

- Tailoring CMMI to emphasize critical process areas for various development lifecycle stages



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Contract Execution SCEs - Phase I



- Tightly integrated prime/sub contractor relationships
 - Prime/sub merged corporate processes into new “project” set of processes
- Schedule of corporate assessments dovetail with Program Office SCE schedule
 - SCEs and corporate assessments take place simultaneously
 - Gov’t SCE focus: project processes
 - Corporate assessment focus: corporate processes

Common Objective: Process Improvement



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Contract Execution SCEs - Phase II

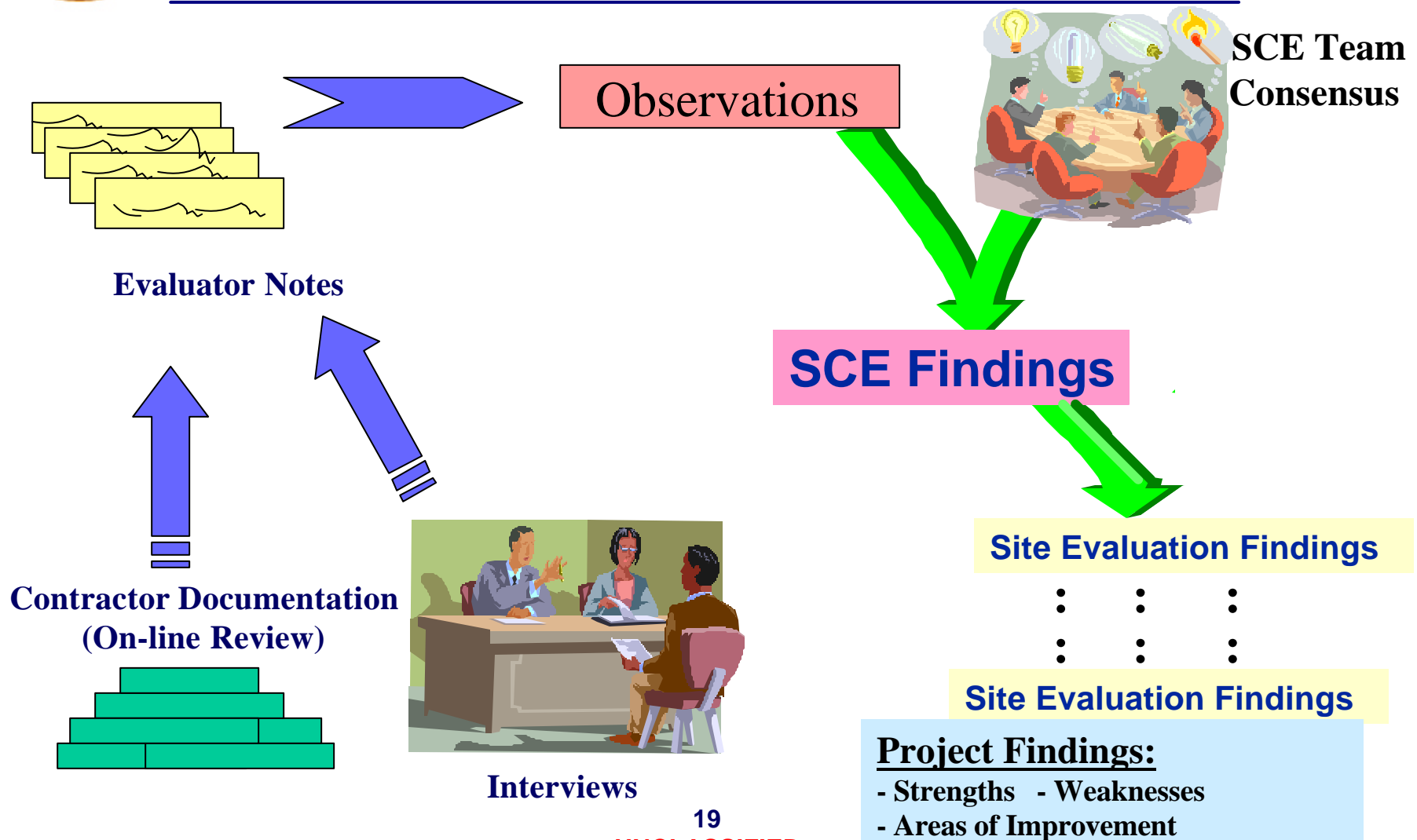


- Different (more traditional) prime/sub contractor relationships
 - Prime defines “umbrella” processes
 - Subcontractors apply corporate strengths (their own processes) to their development activities
- Gov’t SCE team as “service provider” for independent appraisal and CMMI benchmarking for project and contractors
 - In place of / augmentation to corporate internal assessments
 - Prime contractor process group observation across subcontractor SCEs



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SCE Methodology (V3.0) for Contract Execution





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Model for SCE: CMMI

- Merging of SW CMM and EIA 731 (System Engineering CMM)
 - Not government-mandated practices and processes
 - Developed by industry-experts (e.g. Boeing, Raytheon, TRW, Lockheed Martin, Motorola, Harris, Litton, Software Productivity Consortium, SEI)
 - “Best Practices” evident in successful product development
 - Industry thinks these things are critical to success
 - DoD currently transitioning to use CMMI
 - Source selections, contract monitoring, training, etc.



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CMMI-SE/SW/IPPD Version 1.02, Staged



Level	Focus	Process Areas	
5 Optimizing	<i>Continuous process improvement</i>	Causal Analysis and Resolution * Organizational Innovation and Deployment *	<div>Quality Productivity Productivity</div>  <div>Risk Rework</div>
4 Quantitatively Managed	<i>Quantitative management</i>	Quantitative Project Management * Organizational Process Performance *	
3 Defined	<i>Process standardization</i>	Requirements Development Technical Solution Product Integration Verification Validation * Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management (IPPD) Risk Management Integrated Teaming * Decision Analysis and Resolution Organizational Environment for Integration *	
2 Managed	<i>Basic project management</i>	Requirements Management Project Planning Project Monitoring and Control Measurement and Analysis Process and Product Quality Assurance Configuration Management Supplier Agreement Management	
1 Initial			

* Not evaluated during the baseline SCEs



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SCE Findings Categories

- **Strength** - a particular part of the *product development* process capability that is sufficiently robust to mitigate the development risks due to process - exceeds what the standard requires
 - ***All strengths are not the same magnitude***
- **Weakness** - a particular part of the product development process capability that has characteristics that increase the risks due to process
 - ***All weaknesses are not the same severity***
- **Improvement Activity** - a process improvement that is not yet institutionalized which potentially mitigates the development risks due to process



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Results of Contract Execution SCEs

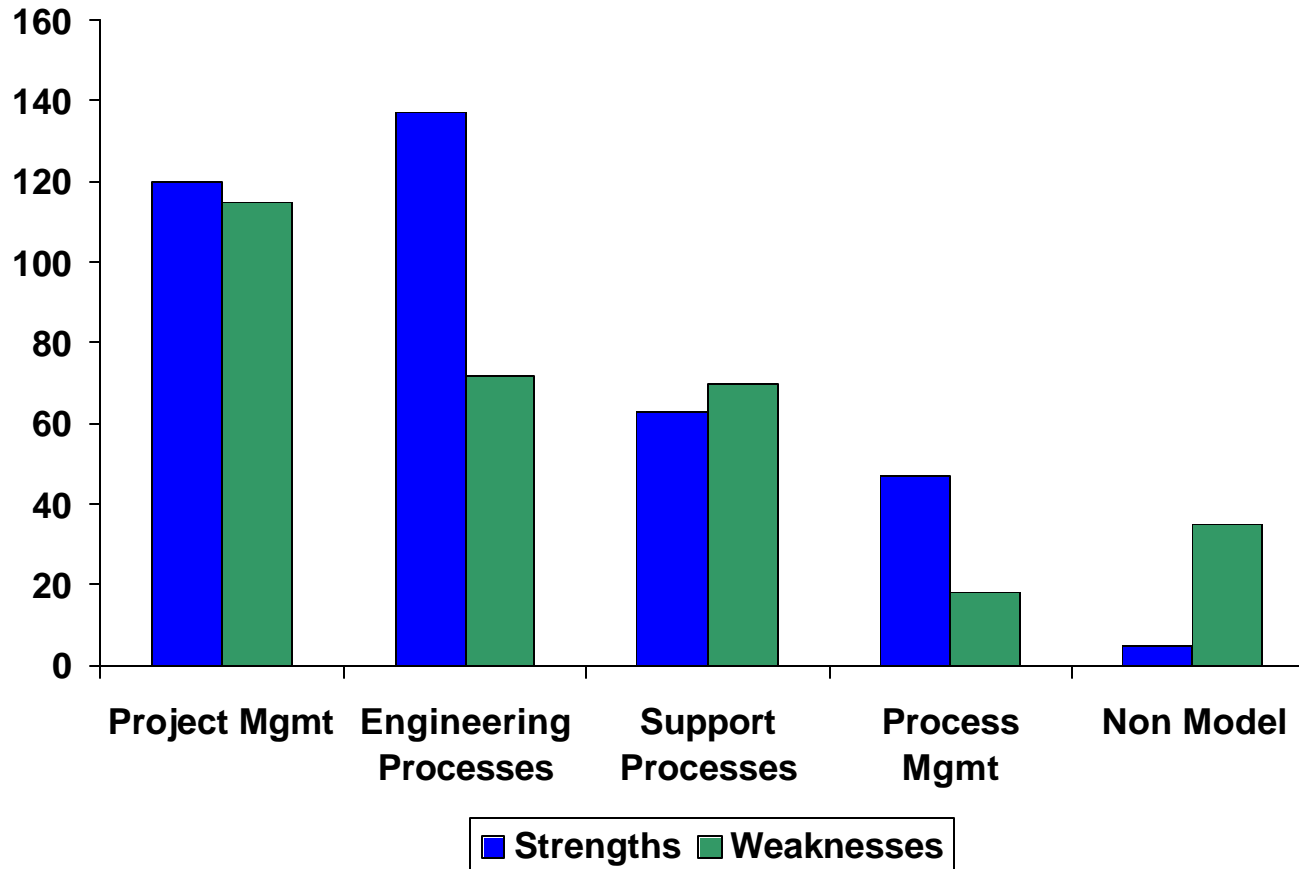


- Findings from all sites combined into a set of “program findings”
 - ➔ 684 Program Findings (specific problems or strengths
(~ 55% program strengths; ~ 45% program weaknesses => risks))
- “Affinity Grouped” Weaknesses to correct systemic problems, not just symptoms
 - For example: “Artifact Management” would combine findings from CM, RM, RD, TS, etc.
- 11 Risk areas / Process Improvement Categories identified
 - Being used as the basis for project process improvement activities



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Program Characterization by Process Grouping



Project Mgmt Processes:

- Project Planning
- Project Monitoring & Control
- Integrated Project Mgmt
- Risk Management

Engineering Processes

- Requirements Mgmt
- Requirements Definition
- Technical Solution
- Product Integration
- Verification (Peer Reviews)

Support Processes

- Measurement & Analysis
- Product and Process Quality Assurance
- Configuration Mgmt
- Decision Analysis

Process Mgmt

- Organizational Process Focus
- Organizational Process Definition

684 SCE Findings across all program sites

373 Strengths

311 Weaknesses/improvement opportunities



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Progress in Action-Plan Implementation₁

- **Good News:**

- **One program segment (prime and subcontractor teams)**

- 73 findings resulted in 41 Action Plans (through Affinity Grouping)
 - Thirty (30) were implemented within 6 months of SCE
 - Additional eight (8) implemented within 9 months of SCE
 - Three (3) still in work
 - Program Mgmt (contractor and gov't) briefed monthly on progress
 - Continuing to gather “evidence” of process use and effectiveness

- **Major subcontractor:**

- 31 findings resulted in 24 action plans
 - 24 on-track to be implemented within 9 months of SCE

- **Additional Subcontractor:**

- 22 findings resulted in 22 action plans
 - All 22 corrected within 6 months of SCE



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Progress in Action-Plan Implementation₂



- **Less progress by some contractors in one program segment:**
 - More challenged by corporate process improvement climate
 - Requires additional “carrots and sticks” to understand implications of SCE weaknesses
 - Less willing to endure costs/efforts to improve processes without better understanding of pay-off



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Lessons Learned – Applying the SCE Methodology -1

- Establishing single team evaluating contractor across FIA ensures consistent treatment
 - 6 primary SCE Team members (government, FFRDC, SETA and SEI)
 - Augmentees trained & available to fill for core team members
 - Replenishment strategy in place to insure full team in place
 - SEI provides “lead evaluator” or coaches until government members meet requirements
 - Program office now has 4 lead evaluators “certified” by SEI
 - Team members trained and experienced in SW-CMM, CMMI and SCE methods from source selection evaluations
- SCE Team resources and staffing demonstrates management commitment**

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Lessons Learned – Applying the SCE Methodology - 2



SCEs CAN be cost effective

- Met management challenge to minimize SCE overhead borne by Contractors
 - No special filing or data gathering requirements to provide evidence for SCE
 - Off-site review of software documentation “on-line” prior to site visit
 - “On-Site” time limited to support interviewing only
 - 10-15 interviews per site (including call-backs)
 - Used primarily group interviews
 - No pre-interview prep or post-interview debrief required
 - No special “care and feeding” stipulations from program office ala source selection SCEs
 - SCE team visit treated like any other program office visit to support IPTs (in fact member of Project Process Group IPT)



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Lessons Learned – Applying the SCE Methodology - 3



SCEs CAN be cost effective (continued)

- Leverage corporate assessments and audits
 - SCE's piggyback on or replace certain, already planned, Quality Audit/Assessments.
 - Minimizes additional impact or scope to the program
- Using CMMI allows focus on both critical software and system engineering process areas
 - Actually provides more insight into software development lifecycle than SW-CMM



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CMMI Lessons Learned

- Allows in-depth focus on software development
 - SW Engineering intensive processes now have separate process areas for added visibility into design, implementation and testing
- Allows in-depth focus on system engineering leading to product development
 - Understand how risk management, decision analysis, trade studies and CAIV being used to develop product
- Allows in-depth focus on program planning, management and control that will affect program's ability to meet cost, schedule and cost objectives



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Summary

- IMINT has been actively engaged in CMM-based acquisition, risk management, and contract monitoring activities
 - SCEs were used effectively and meaningfully during source selection
 - SCEs are being effectively and meaningfully used during contract execution to identify program risks and to incentivize contractor community to use mature development processes
 - CMMI has brought greater insight into program ability to meet cost, schedule, performance objectives